Muscovite

Michael Doon[1], Djordje Grujic[1], Isabelle Coutand[1], Nicholas Whynot[1]

[1] Department of Earth Sciences, Dalhousie University, Halifax, NS B3H 4J1, Canada, dgrujic@dal.ca

Kinematic models for the tectonics of the Lesser Himalayan Sequence (LHS) are primarily based on structural data and balanced cross sections. Thermochronological and metamorphic constraints are however scarce because of the unsuitable mineral assemblages. Here we present $^{40}Ar/^{39}Ar$ ages of detrital muscovite from the Gondwana sequence at the base of the LHS in the Sikkim Himalaya. In this segment of the orogen the LHS is characterised by a complex Rangit duplex system with the Main Boundary thrust (MBT) as the sole thrust and the Ramgarh thrust as the roof thrust (Bhattacharyya and Mitra, 2009). The interference between the Rangit duplex and a NS trending antiform has formed a double tectonic window: the Sikkim half window outlined by the MCT and the inner Rangit window outlined by the Ramgarh thrust. The hinge of this transverse antiform is located along the Tista River, one of the few trans-Himalayan rivers. Study of erosion and rock uplift rates of the window therefore contributes to testing the hypothesis that *Himalayan river antiforms* may be the consequence of focused rock uplift in response to significant differences between net erosion along major rivers and surrounding regions (Montgomery and Stolar, 2006).

Arkose samples from Permian Gondwana sequence were collected at the orogenic front and from the Rangit window in the interior of the orogen. The individual muscovite ages range between 342.5 ± 52.1 and 1783.6 ± 9.5 Ma. All samples yield multiple age-frequency peaks. The dominant peak in all samples is centered at 480-490 Ma, and three smaller peaks are centered at ~800-900 Ma, ~1100 Ma and ~1800 Ma. The closure temperature for the muscovite in our samples is estimated to be ca. 425 °C. The Tertiary burial of Gondwana sediments therefore did not exceed this temperature.

Furthermore, we have performed Raman spectroscopy on carbonaceous material (RSCM) on slates in the hanging wall of the Ramgarh thrust to determine their peak metamorphic temperatures. The RSCM data yield temperatures of ~440 °C. This is consistent with the findings in the eastern Bhutan (Whynot and others, this volume) which indicate RSCM temperatures of ca 350 °C in the hanging wall of the MBT jumping to > 450 °C in the hanging wall of the Shumar thrust, which is the lateral equivalent of the Ramgarh thrust.

The most likely source for Cambrian-Ordovician muscovite grains are the granites of similar age observed along the entire Himalaya orogen (Cawood and others, 2007) but also at a few locations in the Indian basement in the Himalayan foreland. At this time, our preferred model to explain the provenance of sediments invokes a Permian northward-flowing river system supplying the detritus to the Gondwanan basins. Considering peak metamorphic temperatures, maximum burial estimated from NS and EW cross sections, and a likely geothermal gradient, we conclude that the Tertiary peak-temperature distribution in the LHS of Sikkim is compatible with the river incision and concomitant transverse antiform amplification.

References

Bhattacharyya, K. and, Mitra, G., 2009, A new kinematic evolutionary model for the growth of a duplex — an example from the Rangit duplex, Sikkim Himalaya, India, Gondwana Research, 16, 697-715.

Cawood, P. A., Johnson, M. R. W. and Nemchin, A. A., 2007, Early Paleozoic orogenesis along the Indian margin of Gondwana: Tectonic response to Gondwana assembly, Earth and Planetary Science Letters, 255, 70-84.

Montgomery, D. R. and Stolar, D. B., 2006, Reconsidering Himalayan river anticlines, Geomorphology, 82, 4-15.

Whynot, N., Grujic, D., Long, S. and McQuarrie, N., 2010, Apparent temperature gradient across the Leasser Himalayan Sequence: Raman spectroscopy on carbonaceous material in the eastern Bhutan Himalaya, *in* Leech, M.L., and others, eds., Proceedings for the 25th Himalaya-Karakoram-Tibet Workshop: U.S. Geological Survey, Open-File Report 2010-1099.

Cite as: Doon, M., Grujic, D., Coutand, I. and Whynot, N., 2010, Muscovite, *in* Leech, M.L., and others, eds., Proceedings for the 25th Himalaya-Karakoram-Tibet Workshop: U.S. Geological Survey, Open-File Report 2010-1099, 2 p. [http://pubs.usgs.gov/of/2010/1099/doon/].